



# Extending the Performance Analysis Toolset

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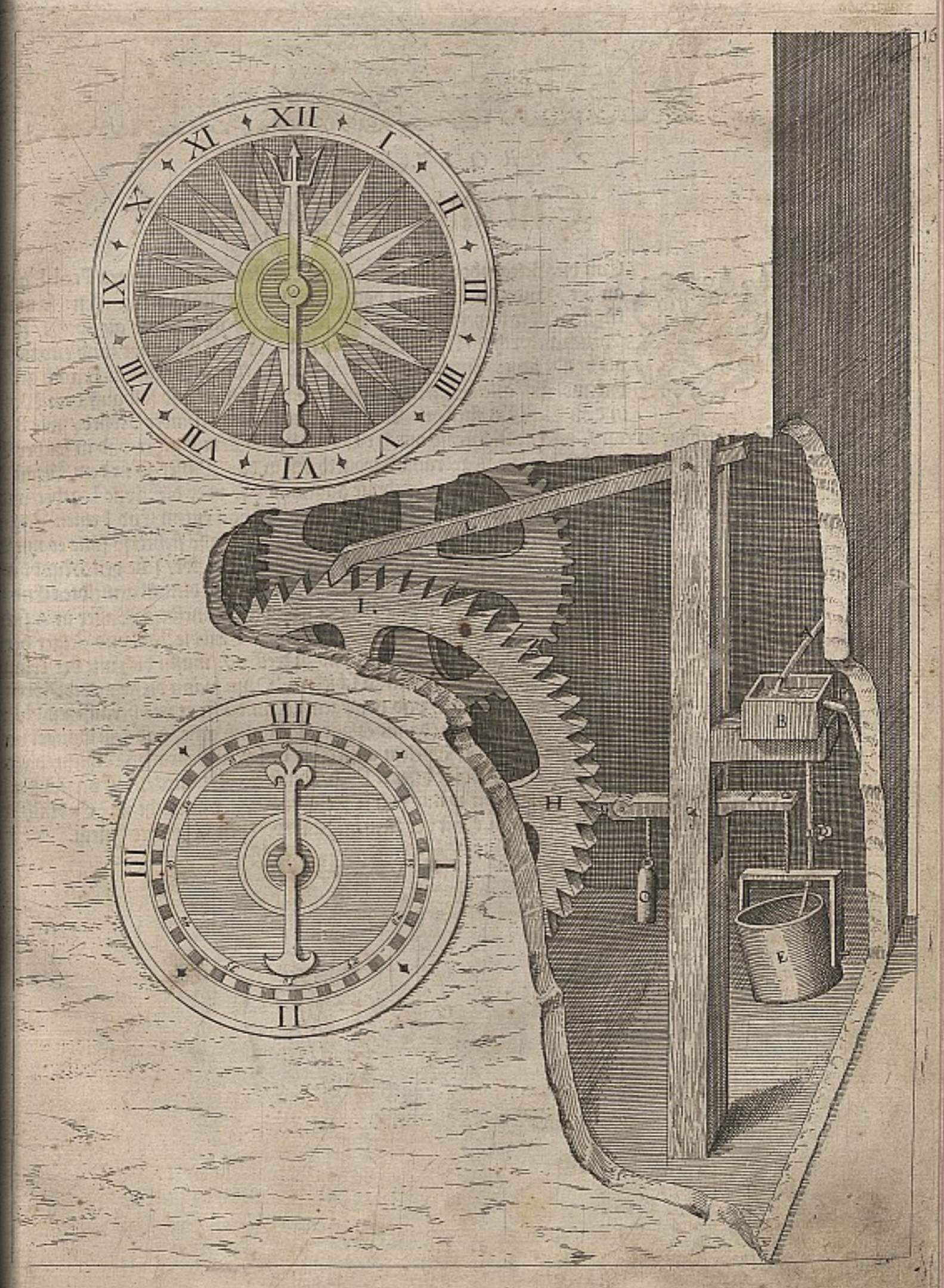




# Embedded Performance

This system is *different* than your desktop.  
Time in this system is spent *differently*.

be scientific and measure!





1

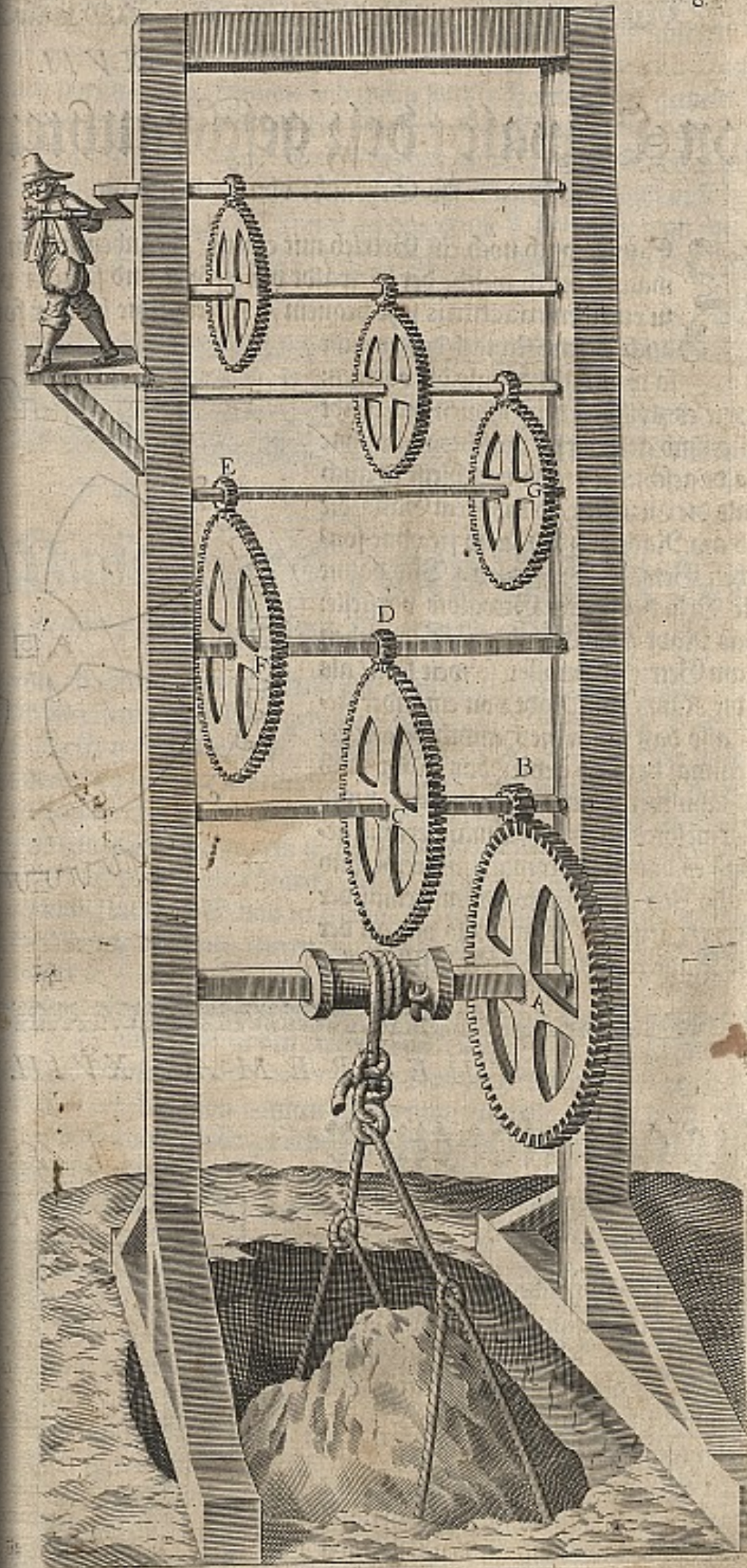
Get sampling performance information with Perf & Symbols.

2

Analyze the info to change your code with Hotspot.

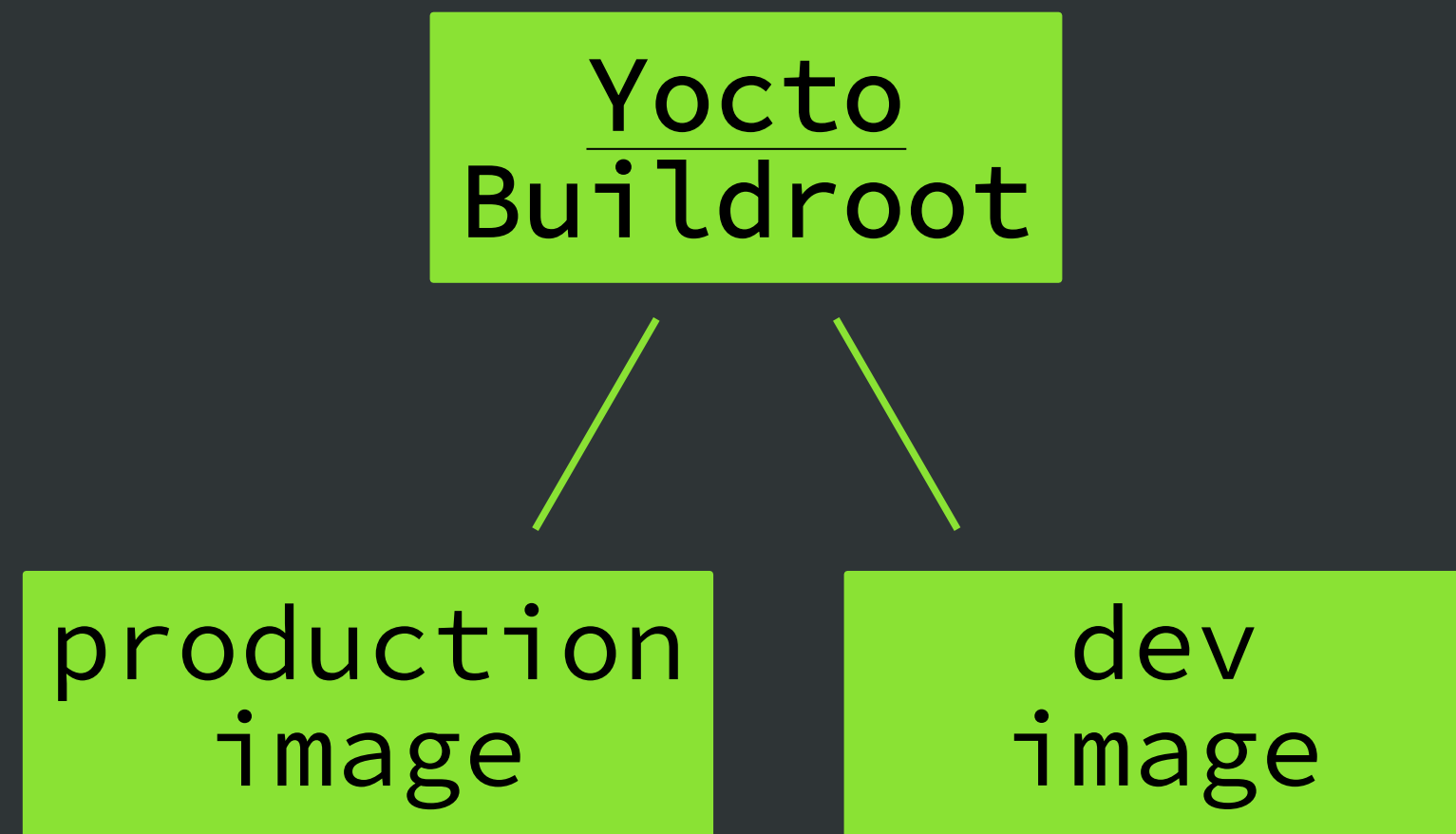
3

Produce additional, different information with LTTNG Userspace Tracing in Qt.



# Linux Perf

Don't forget perf in your  
Kernel Config!



```
$ zgrep -E "PERF|TRACE" /proc/config.gz
```

```
[...]
```

```
#can we do perf at all?
```

```
CONFIG_HAVE_PERF_EVENTS=y  
CONFIG_PERF_EVENTS=y
```

```
#can we do dwarf unwinding?
```

```
CONFIG_HAVE_PERF_REGS=y  
CONFIG_HAVE_PERF_USER_STACK_DUMP=y
```

```
# do we have tracepoints?
```

```
CONFIG_FTRACE=y  
CONFIG_TRACEPOINTS=y  
CONFIG_SCHED_TRACER=y  
CONFIG_HAVE_SYSCALL_TRACEPOINTS=y
```

# Debugsyms:

For Profiling:

Always build Release with Debug info!

```
int intSum(int to)
{
    int sum = 0;
    for (int i = 0; i < to; ++i) {
        sum += i;
    }
    return sum;
}
```

#Compiled with and without -O2



# Debugsyms:

How does the (embedded) world look like ?

We don't have space



libQt5Core.so

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libQt5Core.so

Separate dwarf debug Info

.debug  
on host  
(somewhere in SDK)



# Debugsyms:

How does the (embedded) world look like ?

Architectures mismatch



# Debugsyms:

How does the (embedded) world look like ?

Architectures mismatch



unwind embedded architecture  
SP info on the host.

# Linux Perf

Does the CPU support low-overhead with PMU?

Look for "PMU" in dmesg

-> on some ARM CPUs only core0 is counted.

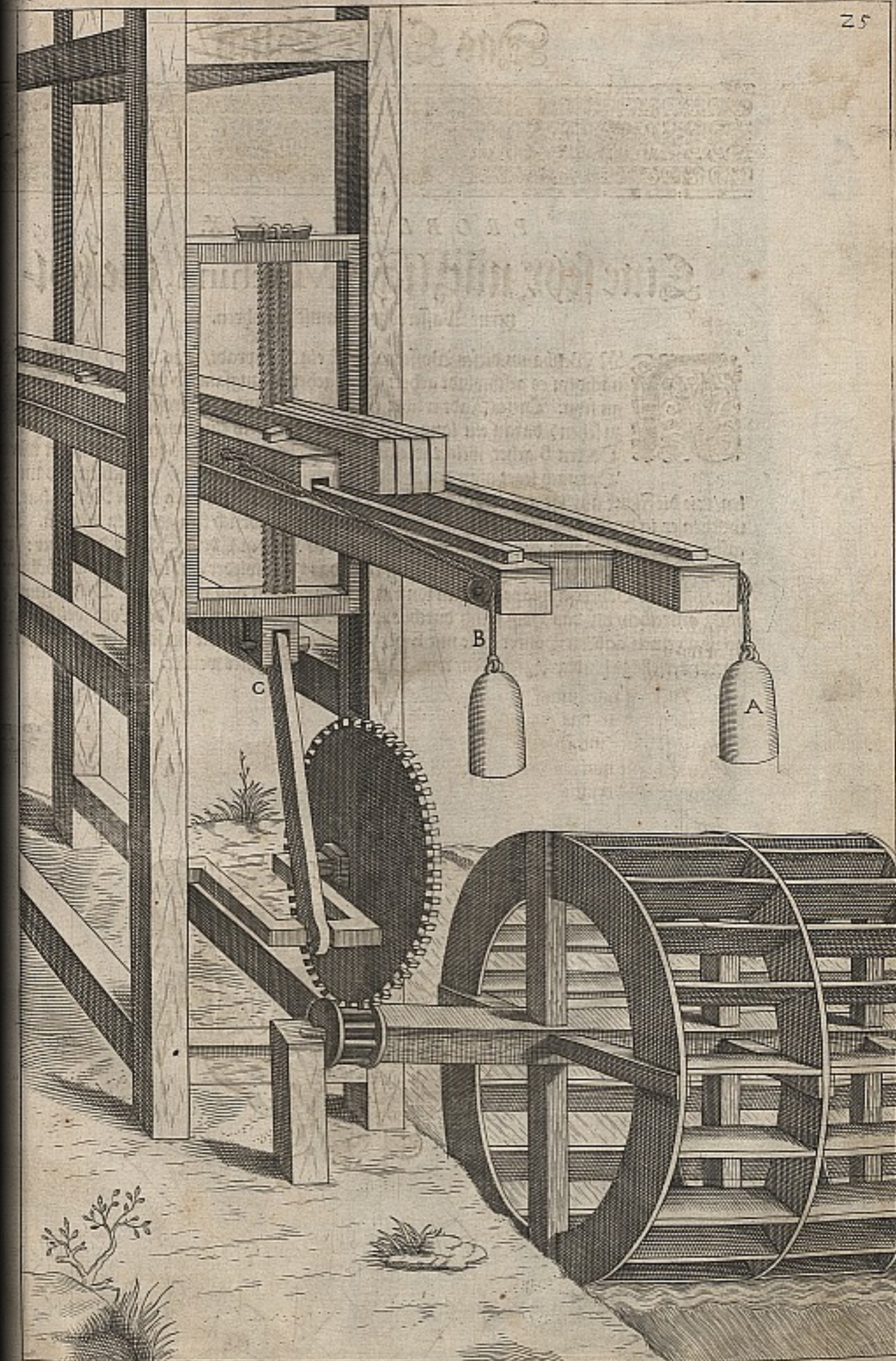
Lets Get our debug info.

```
target ~$ perf record --callgraph dwarf -- myapp
```



# Hotspot

Now We have our profiling  
Info, we need to process it.





# On the device unwind result looks like this

Samples: 1K of event 'cycles:uppp', Event count (approx.): 1524000000

| Children | Self   | Command         | Shared Object           |
|----------|--------|-----------------|-------------------------|
| + 36.61% | 11.42% | settings        | libc-2.26.so            |
| + 29.33% | 5.84%  | settings        | libQt5Qml.so.5.10.0     |
| + 28.41% | 7.94%  | settings        | libQt5Core.so.5.10.0    |
| + 27.76% | 1.05%  | settings        | settings                |
| + 23.16% | 2.30%  | settings        | libglib-2.0.so.0.5400.0 |
| + 20.34% | 1.38%  | settings        | libQt5Quick.so.5.10.0   |
| + 20.14% | 0.07%  | settings        | libQt5XcbQpa.so.5.10.0  |
| + 19.29% | 1.51%  | settings        | libQt5Gui.so.5.10.0     |
| + 15.81% | 2.76%  | QSGRenderThread | libQt5Quick.so.5.10.0   |
| + 14.11% | 11.88% | QSGRenderThread | i965_dri.so             |
| + 14.11% | 2.82%  | QSGRenderThread | libc-2.26.so            |
| + 13.85% | 0.92%  | QSGRenderThread | libQt5Core.so.5.10.0    |
| + 13.65% | 0.33%  | QSGRenderThread | libpthread-2.26.so      |
| + 12.86% | 0.85%  | QQuickPixmapRea | libc-2.26.so            |
| + 12.20% | 0.20%  | QQuickPixmapRea | libQt5Core.so.5.10.0    |
| + 12.07% | 0.07%  | QQuickPixmapRea | libpthread-2.26.so      |
| + 12.07% | 0.00%  | QQuickPixmapRea | libQt5Quick.so.5.10.0   |
| + 12.01% | 0.26%  | QQuickPixmapRea | libQt5Gui.so.5.10.0     |
| + 12.01% | 0.00%  | QQuickPixmapRea | settings                |
| + 11.35% | 3.94%  | QQuickPixmapRea | libpng16.so.16.34.0     |
| + 11.09% | 4.86%  | settings        | libpng16.so.16.34.0     |
| + 8.27%  | 0.00%  | settings        | [unknown]               |

# On the device unwind result looks like this

Samples: 1K of event 'cycles:uppp', Event count (approx.): 1524000000

| Children                            | Self  | Command                | Shared Object | Symbol                |
|-------------------------------------|-------|------------------------|---------------|-----------------------|
| - 22.83%                            | 0.00% | settings               | libc-2.26.so  | [.] __libc_start_main |
| - __libc_start_main                 |       |                        |               |                       |
| - 20.54%                            |       | main                   |               |                       |
| - 20.08%                            |       | QCoreApplication::exec |               |                       |
| - QEventLoop::exec                  |       |                        |               |                       |
| - 19.88%                            |       | 0xc5151                |               |                       |
| QEventDispatcherGlib::processEvents |       |                        |               |                       |
| + g_main_context_iteration          |       |                        |               |                       |
| 2.30%                               |       | __libc_csu_init        |               |                       |
| - 22.77%                            | 0.00% | settings               | settings      | [.] _start            |
| _start                              |       |                        |               |                       |
| - __libc_start_main                 |       |                        |               |                       |
| - 20.47%                            |       | main                   |               |                       |
| - 20.01%                            |       | QCoreApplication::exec |               |                       |
| - QEventLoop::exec                  |       |                        |               |                       |
| - 19.82%                            |       | 0xc5151                |               |                       |
| QEventDispatcherGlib::processEvents |       |                        |               |                       |
| - g_main_context_iteration          |       |                        |               |                       |
| - 19.49%                            |       | 0x6cf68                |               |                       |
| - g_main_context_dispatch           |       |                        |               |                       |
| - 16.93%                            |       | 0x2f82d1               |               |                       |
| QTimerInfoList::activateTimers      |       |                        |               |                       |



# Hotspot

Hotspot is a FOSS Linux UI for visualizing perf results written in Qt and C++

... it uses perfparser from QtCreator

... which uses libunwind / libdw for unwinding even off-architecture!

<Demo>

99,5% curtesy goes to @milianw



# Here is what I like most

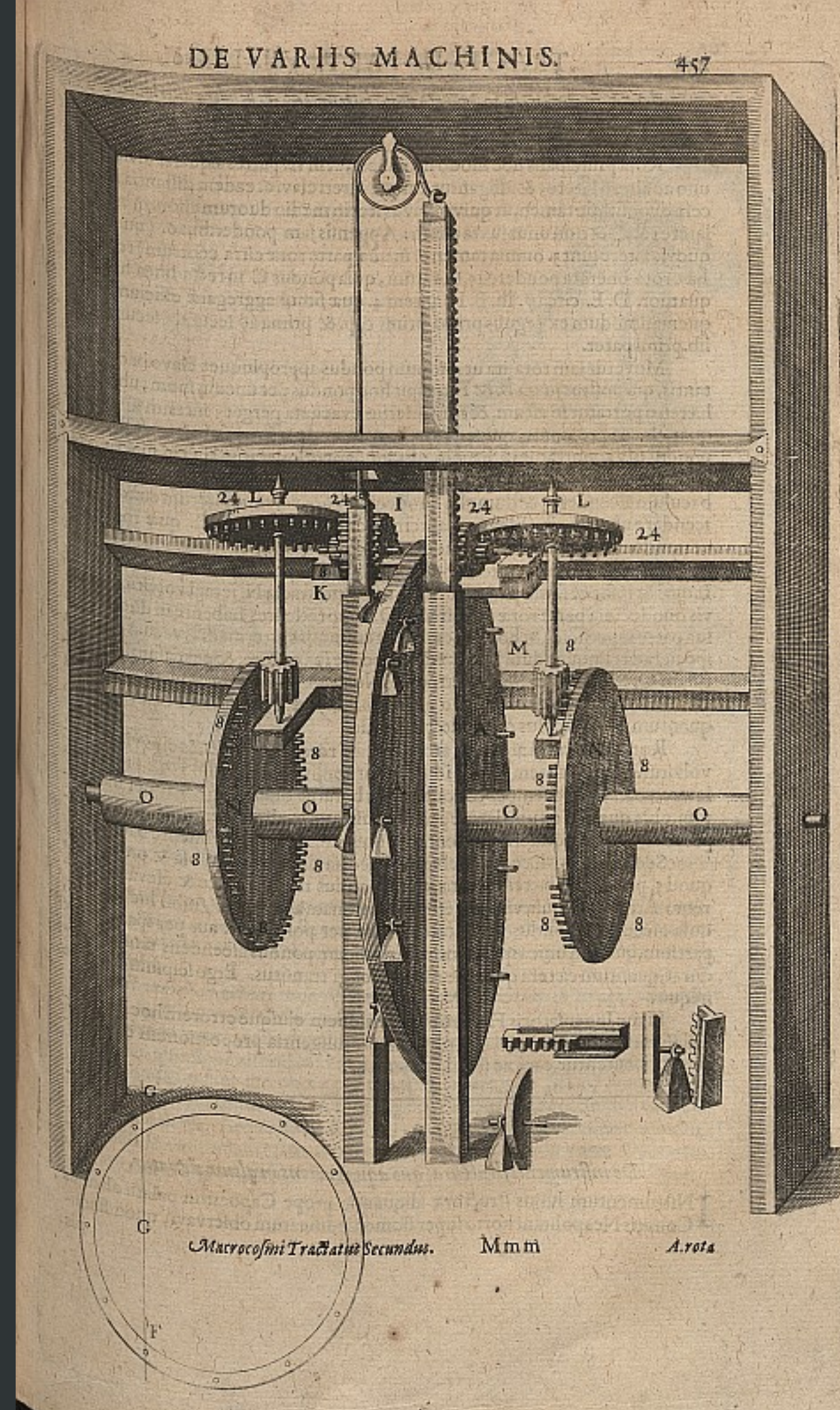


```
# settings to help you  
# unwind off-target  
  
--debugPaths <paths>  
--extraLibPaths <paths>  
--appPath <paths>  
--sysroot <path>  
--kallsyms <path>
```



# LTTNG: We want it inside Qt

Great Source of Information  
Existing Tools, but  
Traces are mostly Kernel :(





| Process          | TID   | PTID  | Birth time         | 17:16:07.695000 | 17:16:07.695500 | 17:16:07.696000 | 17:16:07.696500 | 17:16:07.697000 | 17:16:07.697500 | 17:16:07.698000 | 17:16:07.698500 |
|------------------|-------|-------|--------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| ▼ kernel(11)     |       |       |                    |                 |                 |                 |                 |                 |                 |                 |                 |
| polkitd          | 624   | 1     | 17:16:06.625985267 |                 |                 |                 |                 |                 |                 |                 |                 |
| Xorg             | 1224  | 1222  | 17:16:06.619666556 |                 |                 |                 |                 |                 |                 |                 |                 |
| systemd          | 1     |       | 17:16:06.619703771 |                 |                 |                 |                 |                 |                 |                 |                 |
| sudo             | 15297 | 15197 | 17:16:07.683345211 |                 |                 |                 |                 |                 |                 |                 |                 |
| systemd-journal  | 225   | 1     | 17:16:06.625961338 |                 |                 |                 |                 |                 |                 |                 |                 |
| gdbus            | 650   | 1     | 17:16:06.625986996 |                 |                 |                 |                 |                 |                 |                 |                 |
| Softwar~cThread  | 1936  | 1272  | 17:16:06.614836870 |                 |                 |                 |                 |                 |                 |                 |                 |
| Chrome_~dThread  | 1982  | 1886  | 17:16:06.614942060 |                 |                 |                 |                 |                 |                 |                 |                 |
| Gecko_IOThread   | 1904  | 1272  | 17:16:06.614913257 |                 |                 |                 |                 |                 |                 |                 |                 |
| BHMgr Monitor    | 1930  | 1272  | 17:16:06.614857889 |                 |                 |                 |                 |                 |                 |                 |                 |
| rcu_preempt      | 10    | 2     | 17:16:06.612046349 |                 |                 |                 |                 |                 |                 |                 |                 |
| lttnng           | 15298 | 15297 | 17:16:07.698240556 |                 |                 |                 |                 |                 |                 |                 |                 |
| kworker/3:1      | 60    | 2     | 17:16:06.619720160 |                 |                 |                 |                 |                 |                 |                 |                 |
| Web Content      | 1980  | 1886  | 17:16:06.614983926 |                 |                 |                 |                 |                 |                 |                 |                 |
| BHMgr Monitor    | 1994  | 1886  | 17:16:06.615000868 |                 |                 |                 |                 |                 |                 |                 |                 |
| run_lttnng_trace | 15197 | 1843  | 17:16:06.626413446 |                 |                 |                 |                 |                 |                 |                 |                 |
| ksoftirqd/2      | 29    | 2     | 17:16:06.608722166 |                 |                 |                 |                 |                 |                 |                 |                 |
| rcuc/2           | 28    | 2     | 17:16:06.608716016 |                 |                 |                 |                 |                 |                 |                 |                 |
| sleep            | 15296 | 15197 | 17:16:06.681389769 |                 |                 |                 |                 |                 |                 |                 |                 |
| IPDL Background  | 1946  | 1272  | 17:16:06.614881136 |                 |                 |                 |                 |                 |                 |                 |                 |
| rcu_sched        | 11    | 2     | 17:16:06.625916109 |                 |                 |                 |                 |                 |                 |                 |                 |
| ksoftirqd/0      | 9     | 2     | 17:16:06.625914899 |                 |                 |                 |                 |                 |                 |                 |                 |
| rcuc/0           | 13    | 2     | 17:16:06.625917311 |                 |                 |                 |                 |                 |                 |                 |                 |
| dbus-daemon      | 482   | 1     | 17:16:06.625973936 |                 |                 |                 |                 |                 |                 |                 |                 |
| lttnng-consumerd | 15274 | 15204 | 17:16:06.608443916 |                 |                 |                 |                 |                 |                 |                 |                 |
| swapper/3        | 0     |       | 17:16:06.608443916 |                 |                 |                 |                 |                 |                 |                 |                 |
| lttnng-sessiond  | 15255 | 1209  | 17:16:06.608711373 |                 |                 |                 |                 |                 |                 |                 |                 |
| rcuc/1           | 21    | 2     | 17:16:06.608711373 |                 |                 |                 |                 |                 |                 |                 |                 |
| swapper/2        | 0     |       | 17:16:06.608716016 |                 |                 |                 |                 |                 |                 |                 |                 |
| kworker/1:2      | 170   | 2     | 17:16:06.610839478 |                 |                 |                 |                 |                 |                 |                 |                 |
| kworker/2:0      | 13576 | 2     | 17:16:06.610864409 |                 |                 |                 |                 |                 |                 |                 |                 |
| kworker/0:1      | 43    | 2     | 17:16:06.610864411 |                 |                 |                 |                 |                 |                 |                 |                 |
| swapper/0        | 0     |       | 17:16:06.610864411 |                 |                 |                 |                 |                 |                 |                 |                 |
| ksoftirqd/3      | 36    | 2     | 17:16:06.612116581 |                 |                 |                 |                 |                 |                 |                 |                 |
| rcuc/3           | 35    | 2     | 17:16:06.612123518 |                 |                 |                 |                 |                 |                 |                 |                 |
| BHMgr Monitor    | 2100  | 1886  | 17:16:06.612757854 |                 |                 |                 |                 |                 |                 |                 |                 |



# LTNG in Userspace Qt

Qt has now a tool called tracegen.  
Which creates the tracepoints for qtbase.

```
QGuiApplicationPrivate_init_entry()  
QGuiApplicationPrivate_init_exit()
```

```
QGuiApplicationPrivate_processWindowSystemEvent_entry(int type)  
QGuiApplicationPrivate_processWindowSystemEvent_exit(int type)
```

```
QFontDatabase_addApplicationFont(const QString &filename)  
QFontDatabase_load(const QString &family, int pointSize)  
QFontDatabase_loadEngine(const QString &family, int pointSize)  
QFontDatabasePrivate_addAppFont(const QString &fileName)
```

```
QImageReader_read_before_reading(QImageReader *reader, const QString &filename)  
QImageReader_read_after_reading(QImageReader *reader, bool result)
```



# LTNG in Userspace Qt

They look like this:

```
#ifndef TP_QTGUI_QIMAGEREADER_READ_AFTER_READING
#define TP_QTGUI_QIMAGEREADER_READ_AFTER_READING
namespace QtPrivate {
inline void trace_QImageReader_read_after_reading(QImageReader * reader, bool result)
{
    tracepoint(qtgui, QImageReader_read_after_reading, reader, result);
}
inline void do_trace_QImageReader_read_after_reading(QImageReader * reader, bool result)
{
    do_tracepoint(qtgui, QImageReader_read_after_reading, reader, result);
}
inline bool trace_QImageReader_read_after_reading_enabled()
{
    return tracepoint_enabled(qtgui, QImageReader_read_after_reading);
}
} // namespace QtPrivate
#endif // TP_QTGUI_QIMAGEREADER_READ_AFTER_READING
```

# LTNG in Userspace Qt

And are used like this:

[...]

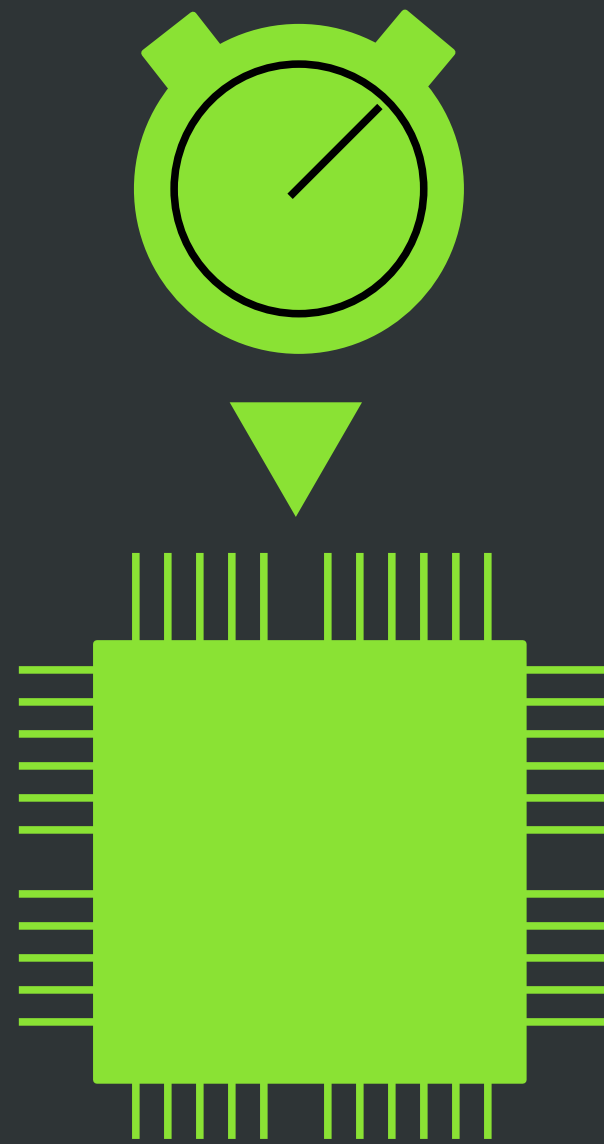
```
// read the image
if (Q_TRACE_ENABLED(QImageReader_read_before_reading)) {
    QString fileName = QStringLiteral("unknown");
    if (QFile *file = qobject_cast<QFile *>(d->device))
        fileName = file->fileName();
    Q_TRACE(QImageReader_read_before_reading, this, fileName);
}
```

```
const bool result = d->handler->read(image);
```

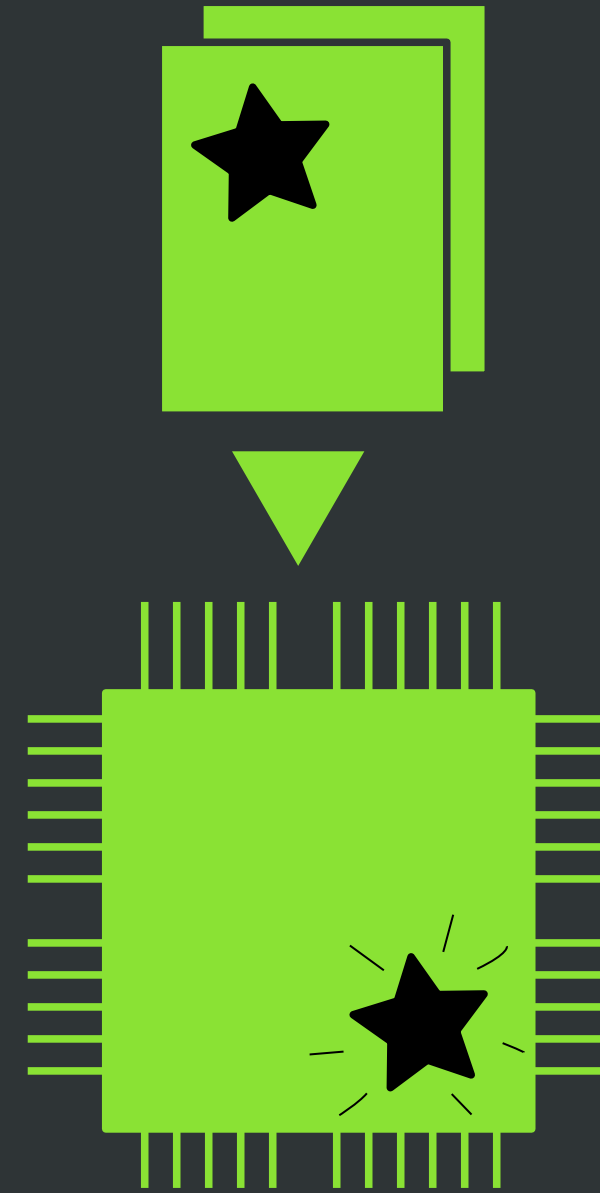
```
Q_TRACE(QImageReader_read_after_reading, this, result);
```

[...]

# How is LTTNG different than perf?



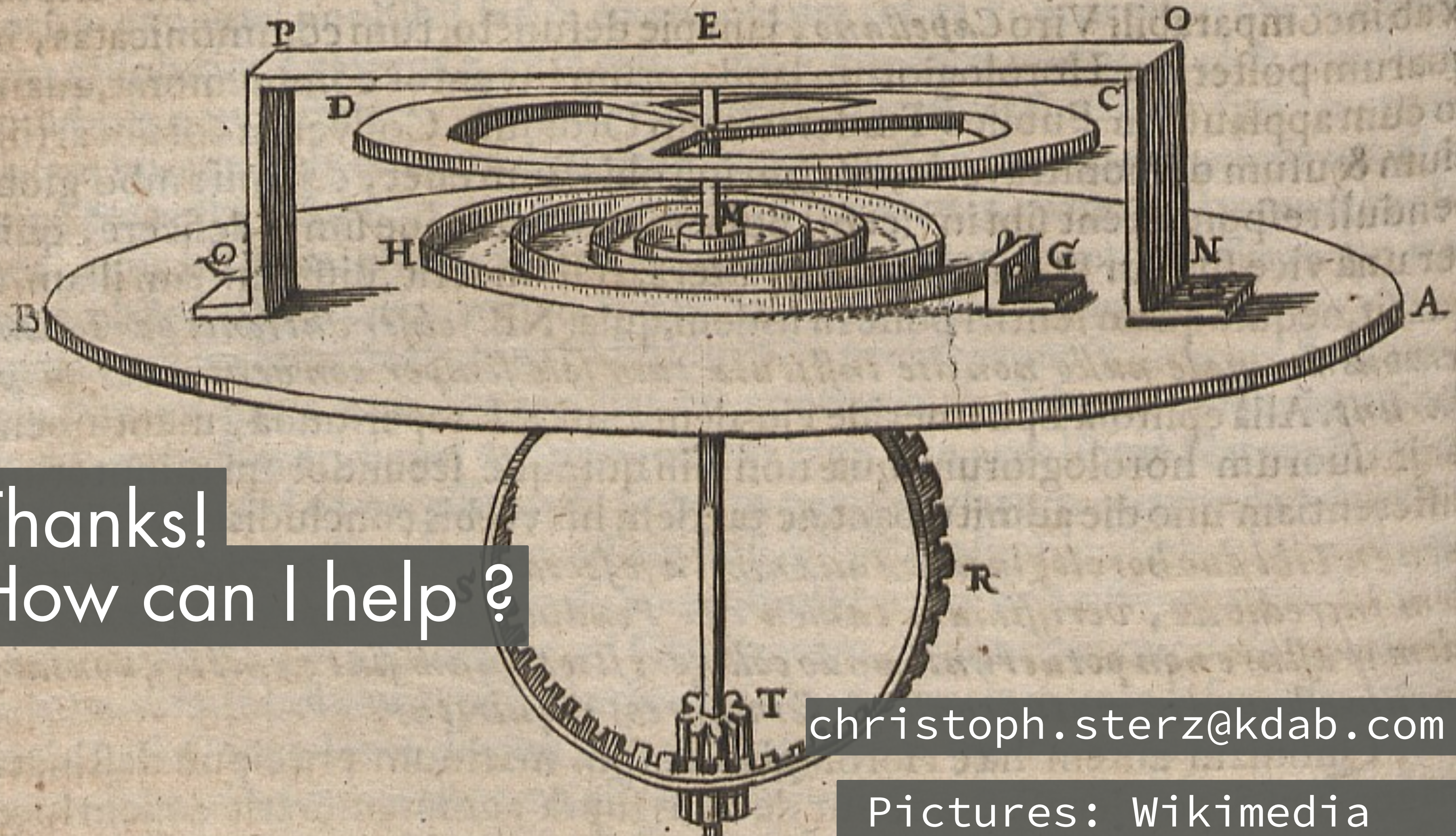
Events



Events



Thanks!  
How can I help ?



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Pictures: Wikimedia